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Low Frequency Wind Generated Ambient Noise Source Levels

Presented at the Australian Bicentennial Conference on Ambient Noise, 27 January 1988, Sydney, New South Wales, Australia

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Most of the wind-generated low frequency ambient noise data have been taken recently in the Southern Hemisphere Oceans. Burgess and Kewley have obtained corresponding source levels that have been implemented in the DUNES Ambient Noise Prediction Model. A survey is made of historical Northern Hemisphere ambient noise data to refine this estimation of source levels. These results are compared with other reported wind-generated noise source levels. (Work sponsored by the Naval Underwater Systems Center.)

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LOW FREQUENCY WIND GENERATED AMBIENT NOISE SOURCE LEVELS

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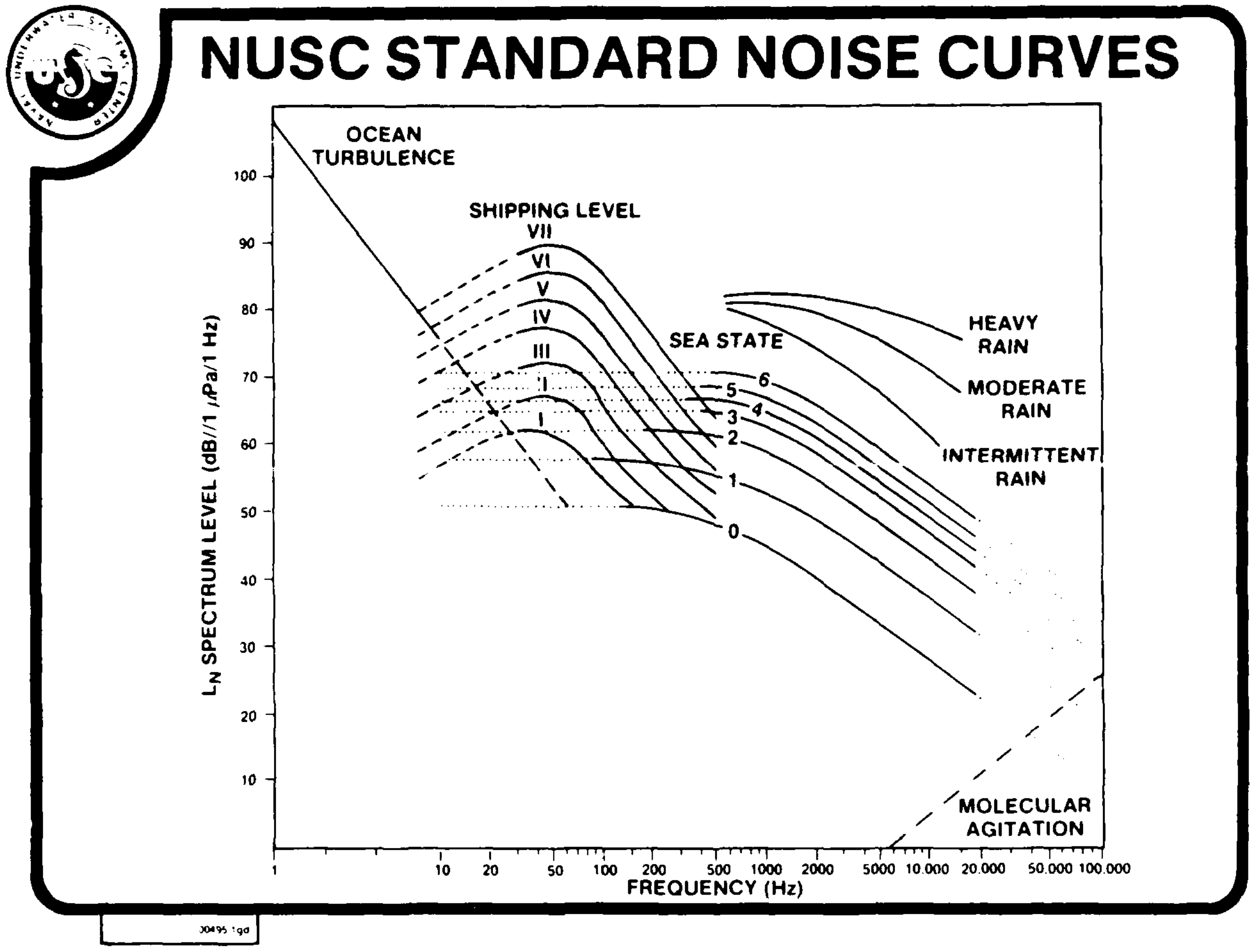
VIEWGRAPH 1

We have been very fortunate to have Dr. Douglas Kewley visiting NUSC for the past eighteen months as a TTCP Exchange Scientist. He brought us up-to-date on the extensive measurements and state-of-the-art model developments that are taking place in Australia and New Zealand. Since we share a common interest in low frequency wind-generated ambient noise, it was a logical next step that we combine our thoughts (and data) to produce our best estimates of low frequency wind-generated ambient noise source levels for this meeting.



VIEWGRAPH 2

The present reality is that prediction models are becoming the dominant method to estimate system performance. To make meaningful comparisons, we must adopt standardized environmental inputs even when they may be only our best estimates. As a first step, we are using a standard set of ambient noise curves at NUSC.

DUNES 2.2 OMNIDIRECTIONAL NOISE

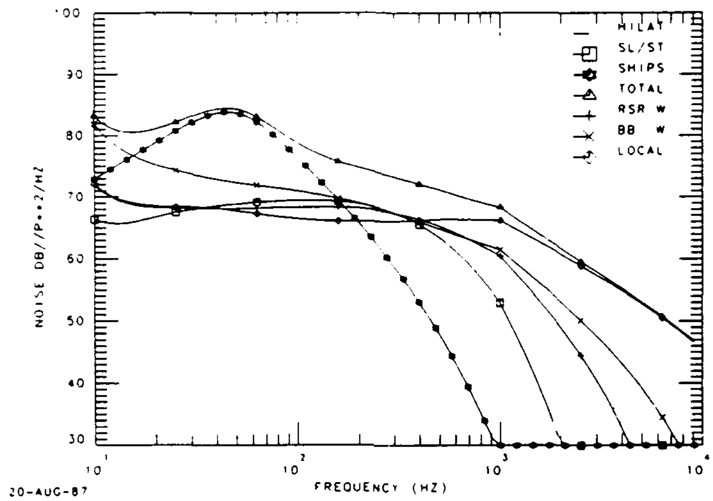
ATLANTIC OCEAN - FEBRUARY
LATITUDE 65.0 DEGS
WINDSPEED 40.0 KNOTS
BOT LOSS GRADIENT 1.0
VERTICAL BOT LOSS 2.0
WINDLANE FRACTIONS
3.0 (N) 0.0 (S)
90 (M) 2590 DEPTH 5.00 KM

SHIP LANE PARAMETERS

TYPE	LEN	RANG	PEAK	BEAR
LANE+	300	260	50	90
LANE+	200	290	50	210
LANE+	200	290	50	210
LANE	440	55	50	90
LANE	280	55	50	315

WIND LANE PARAMETERS

TYPE	LEN	WIDTH	RANG	BEAR	WSPD
SLPE	300	90	260	90	40
SLPE	200	66	290	210	40
SLPE	200	74	350	260	40
SLPE	250	37	500	315	40
SLPE	500	74	730	358	40



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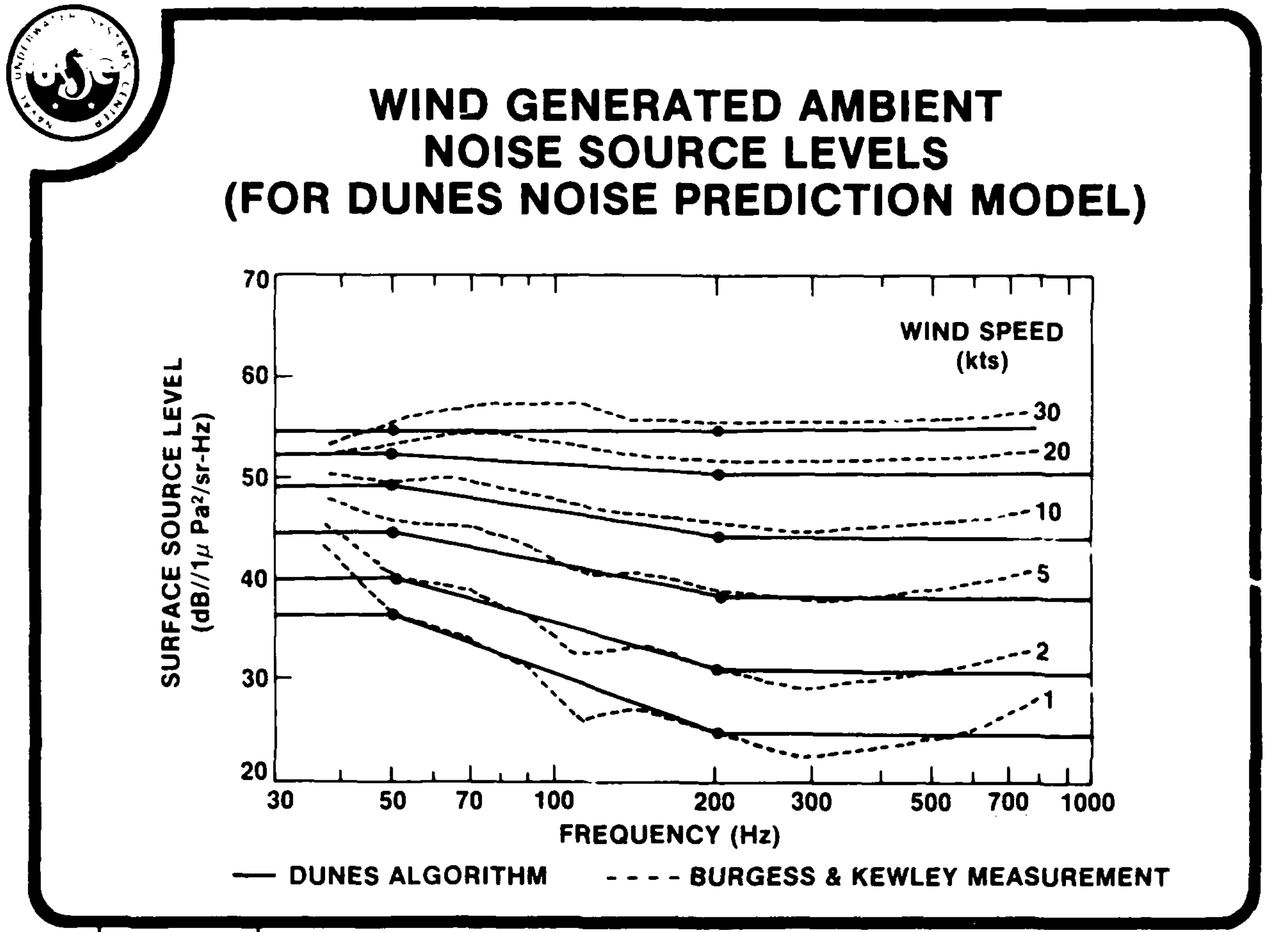
VIEWGRAPH 3

We believe that excellent estimates of ambient noise will be obtained from a prediction model such as DUNES, which was developed by Dick Bannister at the New Zealand Defence Scientific Establishment and Allan Burgess and Douglas Kewley at Defense Science and Technology Organization (DSTO). By treating each acoustic source and propagation mode separately, the program will ultimately give very accurate predictions for any given site. It does require, as one of its key inputs, wind-generated noise source levels for the entire frequency range.



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VIEWGRAPH 4

DUNES presently uses the source level curves shown here, which are based on the classic paper of Burgess and Kewley.* What we have done is add all the historical Northern Hemisphere data we could find to this Southern Hemisphere data base to further refine the wind speed dependency, and then compare our results with recently published data.

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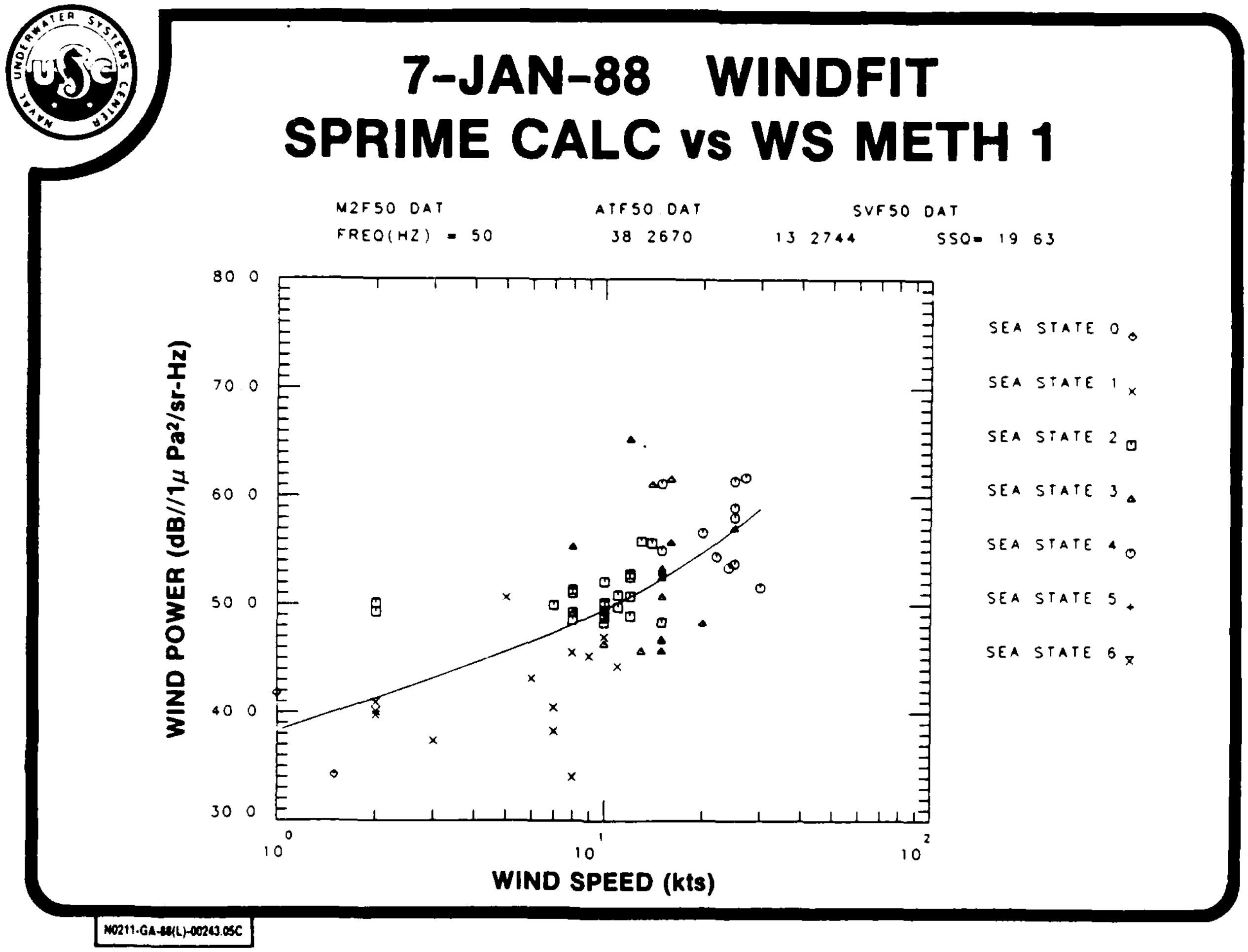
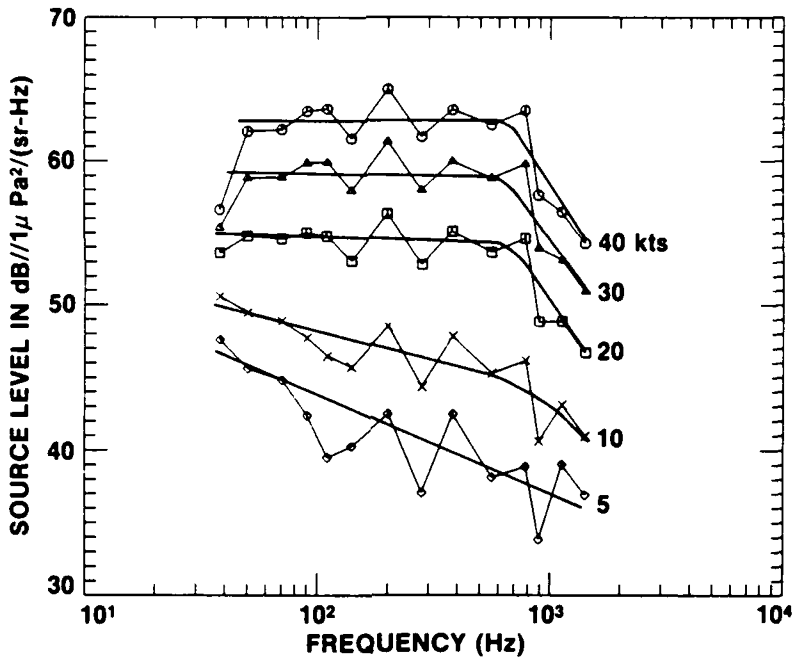
*A. S. Burgess and D. J. Kewley, "Wind-Generated Surface Noise Levels in Deep Water East of Australia," J. Acoust. Soc. Am., vol. 73, no. 1, pp. 201-210 (1983).



VIEWGRAPH 5

A typical sample of the combined data base (50 Hz) with the corresponding fit is shown here. In general, we found an increase of the wind dependency at the higher wind speeds (above 20 knots) over what would be obtained from the Southern Hemisphere data alone.

7-JAN-88 SOURCE LEVEL



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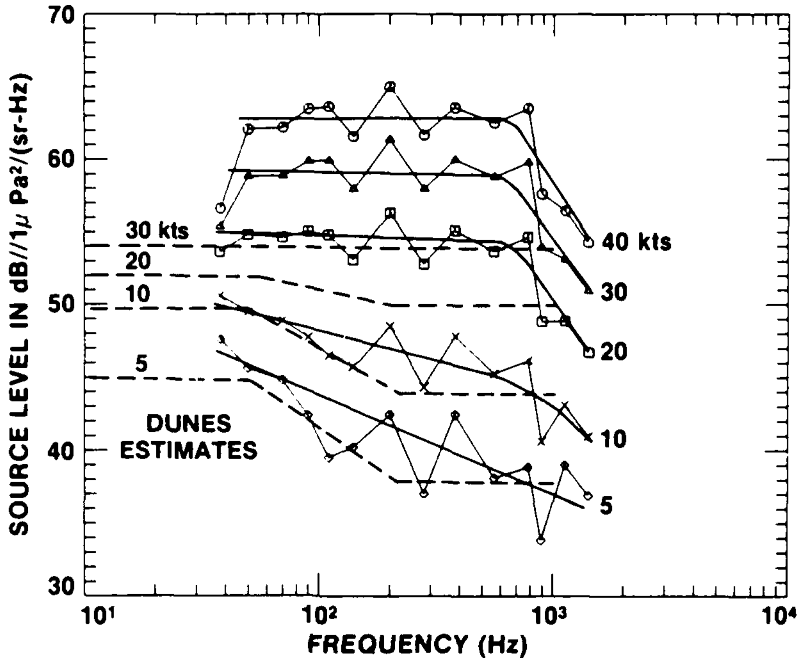
VIEWGRAPH 6

The results of our analyses are given for wind speeds of 5, 10, 20, 30, and 40 knots, along with a hand fit through the data. You can see the change in the frequency dependence between 10 and 20 knots of wind speed, which may be attributed to the start of whitecap formation and gives credence to a two-mechanism explanation for wind noise generation.

7-JAN-88 SOURCE LEVEL

(COMPARISON WITH DUNES ESTIMATES)

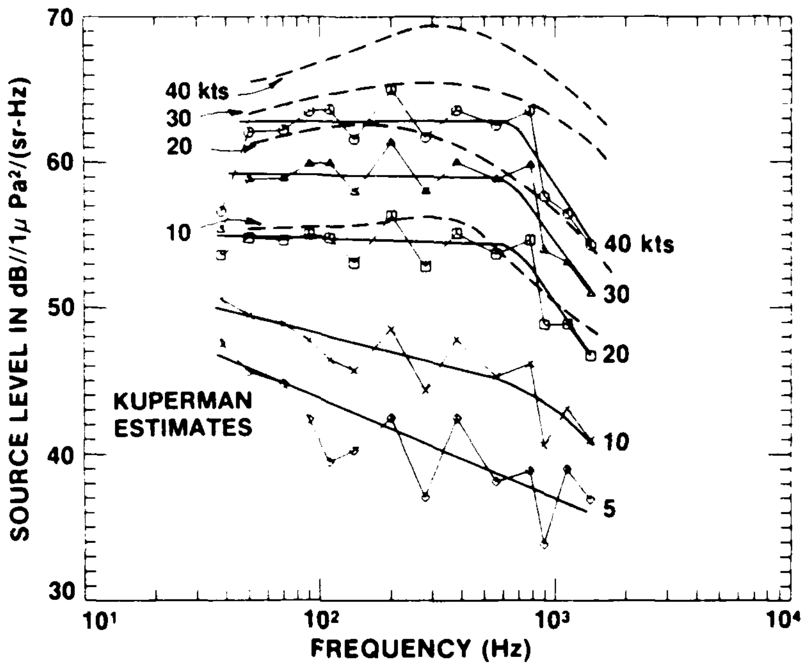


VIEWGRAPH 7

If we now compare the approximate wind-generated noise source level curves presently used in the DUNES model (noted on the left), the agreement is good at the low (5 to 10 knots) wind speeds, but the data are higher at wind speeds above 10 knots.

7-JAN-88 SOURCE LEVEL

(COMPARISON WITH KUPERMAN SOURCE LEVELS)



VIEWGRAPH 8

Kuperman* has recently published (and is presently publishing) several articles on wind-generated source levels based on shallow water propagation measurements. At low frequencies he merges with curves developed by Ross. An initial comparison with Kuperman's source levels as published does not show a good agreement; the shapes are similar but the levels are generally higher.

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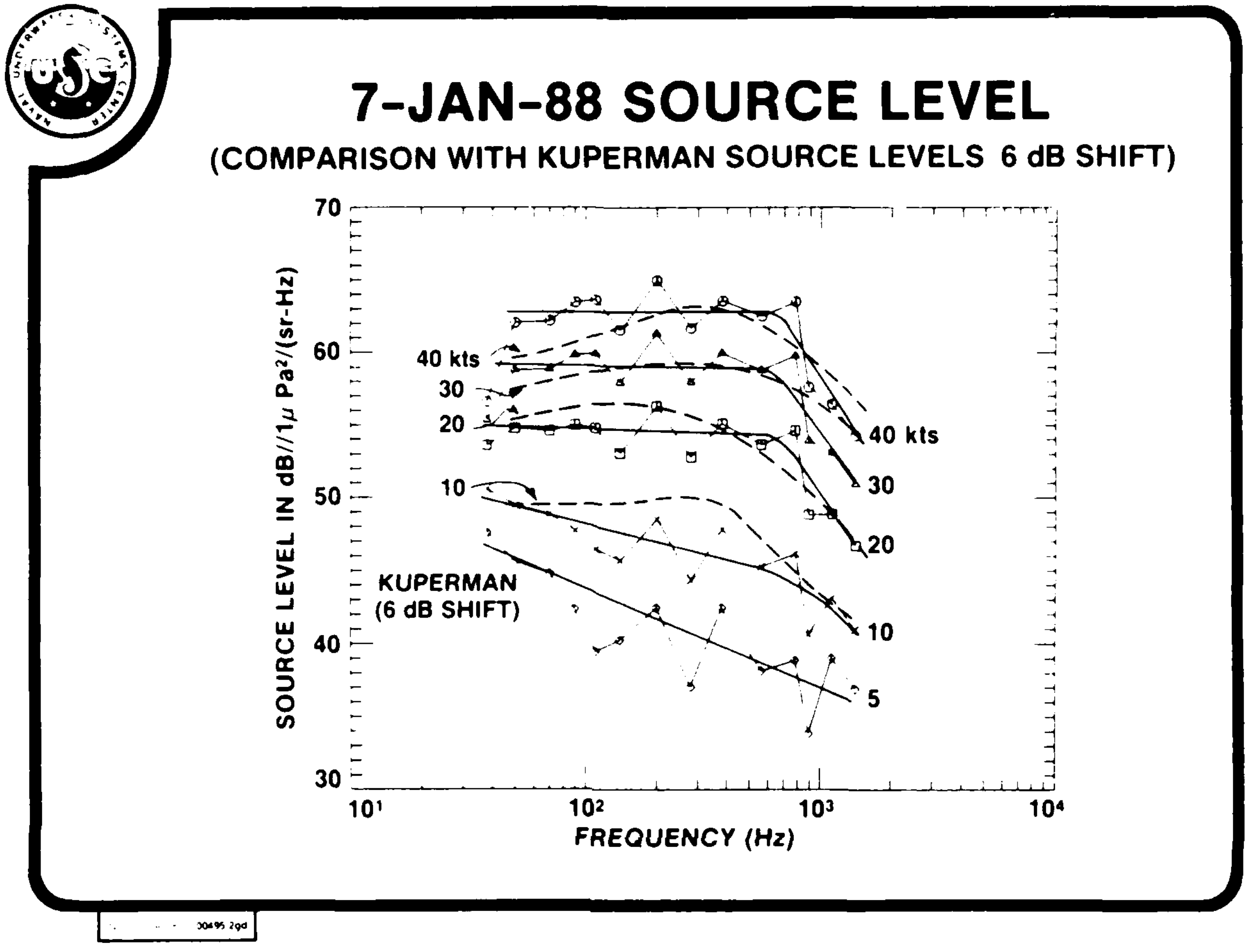
*W. A. Kuperman and M. C. Ferla, "A Shallow Water Experiment to Determine the Source Spectrum Level of Wind-Generated Noise," J. Acoust. Soc. Am., vol. 77, no. 6, pp. 2067-2073 (1985).



VIEWGRAPH 9

Looking for the cause of this difference, we dug back into the basic geometry involved. What we found was that, at least to date, everyone seems to be using either a different geometry or definition of source level -- sometimes even both! π, two π, four π, log of π, etc., are all floating around and it is obvious that we must have standard definitions before we can make meaningful comparisons. When we tried to sort these factors out, we got something like a 6 dB correction between our curves and Kuperman's. With this adjustment, the agreement is reasonably good.

LOW FREQUENCY AMBIENT NOISE SOURCE LEVELS
CONCLUSIONS

- CONSENSUS DEVELOPING
- REQUIRE STANDARD DEFINITIONS
- MORE DATA NEEDED
- REFINE TWO-MECHANISM MODEL

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VIEWGRAPH 10

In conclusion, we can say the following: although we must get our definitions squared away, it does look like a consensus is developing on what the source levels should be. A two-mechanism model is suggested, but more data are needed to refine such a concept.

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